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## EUROPEAN PATENT APPLICATION

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(71) Applicant: **Technology Development Associate  
Operations Limited**  
**Market Harborough, Leicestershire LE16 7PS  
(GB)**

(72) Inventor: **Lowe, John M.**  
**Leicestershire LE16 8BQ (GB)**

(74) Representative: **Snelgrove, Susan Elizabeth**  
**Eric Potter Clarkson**  
**Park View House**  
**58 The Ropewalk**  
**GB-Nottingham NG1 5DD (GB)**

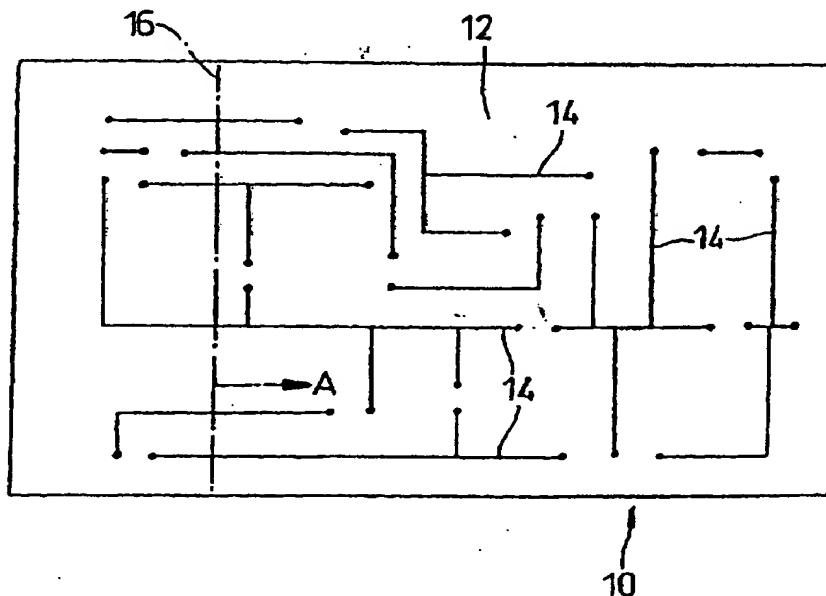
### Remarks:

This application was filed on 18 - 12 - 2002 as a  
divisional application to the application mentioned  
under INID code 62.

### (54) Method of providing conductive tracks on a printed circuit

(57) A method of providing conductive tracks on a  
printed circuit (10) by electro-plating conductive tracks  
(14) which have been produced by printing them onto a  
substrate (12), comprising coating the substrate (12)  
carrying the printed tracks (14) with an electro-plating  
solution using a tool (16) which provides a first electrode

of an electro-plating circuit and with a second electrode  
provided by the tracks (14) which are to be electroplat-  
ed, the conductive tracks (14) being treated with a scan-  
ning electron beam to ionise the tracks and create an  
opposite polarity to the polarity of the first electrode to  
form the second electrode of the electroplating circuit.



**Fig 1**

## Description

[0001] This patent application is a divisional application of European Patent Application number 99914642.6, which claims a method of providing conductive tracks on a printed circuit and an apparatus suitable for use in carrying out the method, as described herein.

[0002] This invention is concerned with a method of providing conductive tracks on a printed circuit.

[0003] A well-known and convenient way of producing printed circuits includes the printing of electrically conductive tracks on a substrate, for example using screen printing techniques. The tracks are printed using an electrically conductive ink which typically comprises a polymeric material having electrically conductive particles, for example copper, silver or other suitable metal, dispersed in the polymeric composition. The polymeric materials are typically cured to a solid condition by subjecting them to radiation for example infra-red radiation or ultra-violet light.

[0004] Although the conductive inks which are used have a sufficient electrical conductivity for use in certain circumstances, the electrical conductivity has in no case been as great as the electrical conductivity of copper or other highly conductive metals. Even the conductive inks with the best performance have electrical conductivities which in most cases are only one tenth of the electrical conductivity of copper. It has been proposed to enhance the conductivity of the conductive tracks in continuous printed circuits by electro-plating the tracks with a suitable layer of metal for example copper but in order to carry out electro-plating it is necessary to have a continuous electrical circuit: that is not conveniently possible where the printed conductive tracks of a printed circuit are discrete and are not connected with one another. Furthermore, electro-plating has required the immersion of the substrate carrying the printed conductive tracks in a bath of suitable electro-plating solution: that technique restricts the substrates which can be subjected to such an immersion electro-plating technique - for example paper based substrates are generally unsuitable as they will tend to be attacked and softened by the electro-plating solution. It has also been proposed to provide a more conductive coating on conductive tracks of printed inks by electroless plating. Electroless plating involves the use of plating solutions which are less stable than those commonly used in electroplating and the process is less readily controlled. Furthermore, electroless plating still requires the substrate to be immersed in the plating solution with the consequent possibilities of attack of the substrate as well as being restricted in the thickness of deposit.

[0005] One of the objects of the present invention is to provide an improved method of providing conductive tracks on a printed circuit by electroplating.

[0006] The invention provides a method of providing conductive tracks on a printed circuit by electro-plating

conductive tracks which have been produced by printing them onto a substrate in accordance with claim 1 of the appended claims.

[0007] In one aspect the invention may be considered to provide a method of providing conductive tracks on a printed circuit by electro-plating conductive tracks which have been produced by printing them onto a substrate, comprising coating a substrate carrying the printed tracks with an electro-plating solution using a tool which provides a first electrode of an electro-plating circuit and with a second electrode provided by the tracks which are to be electroplated and wherein the conductive tracks are treated with a scanning electron beam to ionise the tracks and create an opposite polarity to the polarity of the first electrode and thus form the second electrode of the electroplating circuit.

[0008] In carrying out a method in accordance with the invention the ink forming the conductive tracks preferably comprises a cured polymer composition loaded with electrically conductive particles.

[0009] Preferably in carrying out a method in accordance with the invention use is made of apparatus including a tool which comprises an absorptive member in which the plating solution can be carried, in which the first electrode is in electrical connection with plating solution carried by the absorptive member, and in which the coating of plating solution is applied to the substrate by wiping the absorptive member over the substrate.

[0010] Conveniently in carrying out a method in accordance with the invention the plating solution comprises copper sulphate; however, any suitable electro-plating solution which can be carried by the absorptive member may be used. In carrying out a method in accordance with the invention the conductive tracks are conveniently coated with plating solution sufficient to deposit a layer of copper on the tracks which is of a desired thickness, typically 20 microns ( $\mu\text{m}$ ) in thickness.

[0011] In carrying a method in accordance with the invention, use is preferably made of a tool in accordance with the invention.

[0012] The absorptive member of a tool in accordance with the invention may be provided by any suitable means within which the plating solution may be absorbed - for example the absorptive member may comprise a brush or a flexible foam material having interconnected pores.

[0013] Suitably a tool in accordance with the invention comprises means to feed a supply of plating solution to the absorptive member.

[0014] In another aspect the invention may be considered to provide a printed circuit comprising a plurality of discrete conductive tracks, each track comprising a layer of a cured electrically conductive ink on an electrically insulating substrate and a layer of conductive metal deposited on the cured ink by electro-plating.

[0015] In carrying a method in accordance with the invention it is not necessary to immerse the substrate carrying the conductive tracks in a plating bath. The quan-

tity of plating solution which comes into contact with the substrate is very small and the method can in effect be regarded as a substantially dry electro-plating method: consequently, it is possible to electro-plate tracks on substrates which cannot be electro-plated by an immersion system. Furthermore, in carrying out the preferred method in accordance with the invention, it is not necessary that the conductive tracks be continuous, the use of the scanning electron beam technique enables discreet electrically conductive tracks to be electro-plated. A method in accordance with the invention can be controlled to provide an accurate plating thickness: the thickness of a layer applied by electro-plating is a function of current and time for which the electro-plating solution is in contact with the region to be plated. It is therefore possible to electro-plate regions of a printed circuit to provide electro-plated regions of different thickness thereby permitting adjustment of the resistance of regions of the printed circuit to provide resistors of the circuit. Such a system is particularly conveniently carried out using the scanning electron beam, which can be targeted accurately on to a specific conductive track and moved rapidly to achieve the desired conductivity.

[0016] Although in carrying out a method in accordance with the invention the tool by which the plating solution is applied may be hand held, it is preferable to mount the tool in a suitable machine which may wipe the tool across the surface of the substrate carrying the conductive tracks.

In the accompanying drawings:-

#### [0017]

Figure 1 is a diagrammatic plan view of a printed circuit having discrete conductive tracks showing a tool in accordance with the invention.

Figure 2 is a diagrammatic side view of a tool suitable for use in carrying out a method in accordance with the invention of the parent application to this application and itself illustrating the invention of the parent application in one aspect.

[0018] A printed circuit 10 is shown in Figure 1. The printed circuit comprises a substrate 12 on which are printed a plurality of conductive tracks 14. The tracks 14 are printed onto the surface of the substrate 12 using a screen printing technique, the screen printing ink being provided by a polymeric composition loaded with electrically conductive silver particles and cured by exposure to ultra-violet light to provide a pattern of discrete conductive tracks. The tracks as initially printed using the UV curable ink are of relatively low conductivity.

[0019] In carrying out the illustrative method, of enhancing the conductivity of conductive tracks which have been produced by printing them onto the substrate 12, the substrate carrying the printed tracks 14 is coated

with an electro-plating solution using a tool 16 which is indicated in chain dot line on Figure 1.

[0020] As can be seen viewing Figure 1 the tool 16 extends completely across the substrate 16. Thus, as the tool 16 is wiped across the surface of the substrate, the conductive tracks 14 are electro-plated. The electrical current supplied by the electro-plating circuit, in conjunction with the speed of travel of the tool across the surface of the substrate provides a control of the amount of electro-plating metal which is deposited on the conductive tracks and is suitably controlled to provide a layer of metal electro-plated on to the conductive tracks, which is of a desired thickness, normally between 10 and 15 microns in thickness. Any appropriate electro-plating may be used but a common copper sulphate electro-plating solution may be appropriate.

[0021] When the surface of the substrate 12 has been treated by the tool 16, any excess electro-plating solution may be rinsed from the surface of the substrate 12, if necessary.

[0022] As the lines printed on to the substrate 12 by the curable ink may be relatively fragile the pressure exerted by the tools 16 on the substrate should be very light.

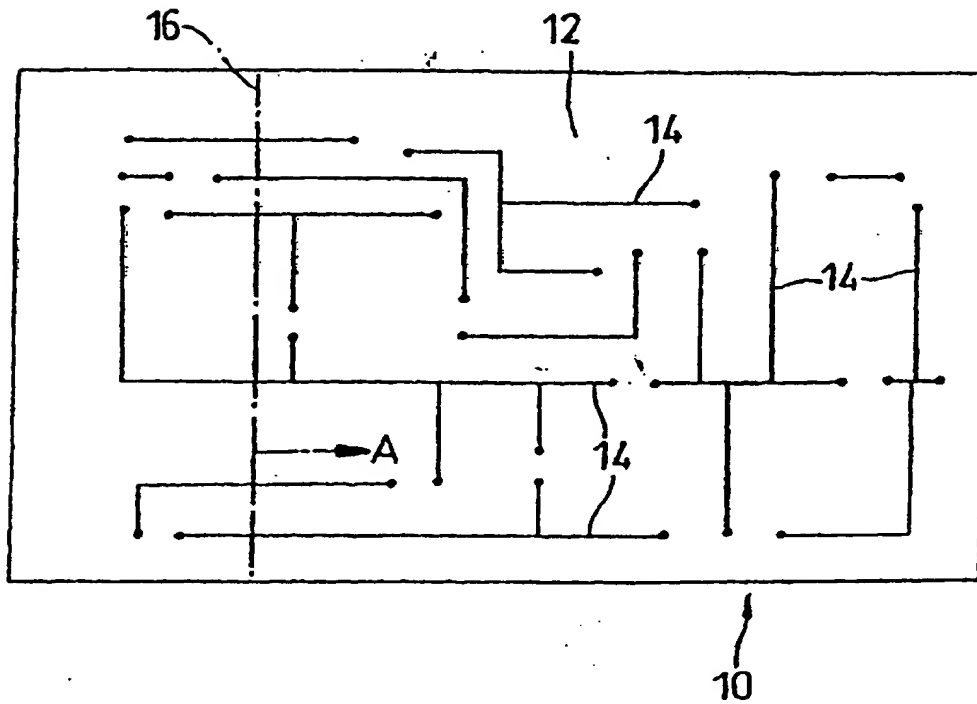
[0023] The illustrative method provides a readily controlled method of electro-plating discrete conductive tracks carried on the surface of a printed circuit substrate. As the substrate is not immersed in an electro-plating bath, and the method is a substantially "dry" method of electro-plating, with only small amounts of electro-plating solution coming into contact with the substrate, it is possible to electro-plate substrates which would be adversely affected by immersion in an electro-plating bath. Furthermore, the method allows electro-plating of discrete conductive tracks which has not hitherto been possible in any convenient manner.

#### Claims

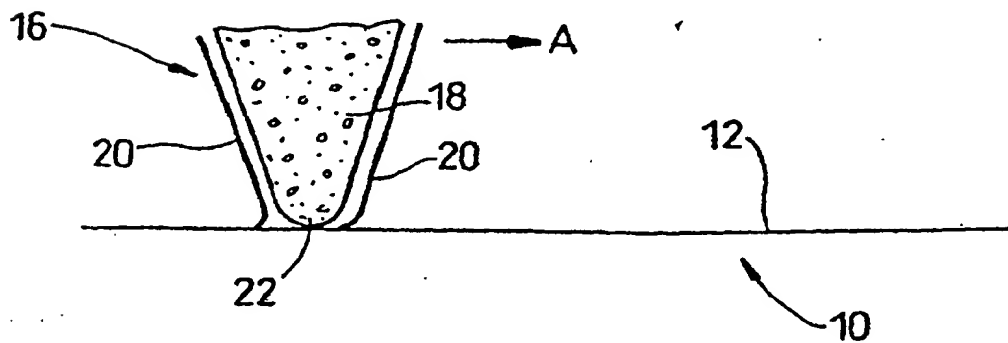
1. A method of providing conductive tracks on a printed circuit (10) by electro-plating conductive tracks (14) which have been produced by printing them on to a substrate (12), comprising coating the substrate (12) carrying the printed tracks (14) with an electro-plating solution using a tool (16) which provides a first electrode of an electro-plating circuit and with a second electrode provided by the tracks (14) which are to be electroplated, **characterised in that** the conductive tracks (14) are treated with a scanning electron beam to ionise the tracks and create an opposite polarity to the polarity of the first electrode to form the second electrode of the electroplating circuit.
2. A method according to claim 1 in which the ink forming the conductive tracks (14) comprises a cured polymer composition loaded with electrically con-

ductive particles.

3. A method according to claim 1 or claim 2 in which the tool (16) comprises an absorptive member (18) in which the plating solution can be carried, in which the first electrode is in electrical connection with the plating solution carried by the absorptive member (18), and in which the coating of plating solution is applied to the substrate (12) by wiping the absorptive member (18) over the substrate (12).
4. A method according to any one of the preceding claims wherein the plating solution comprises copper sulphate.
5. A method according to claim 4 wherein the conductive tracks (14) are coated with plating solution to deposit a layer of copper on the tracks (14) which is about 20 microns (  $\mu$ m) thick.
6. A tool suitable for use in a method in accordance with any one of claims 1 to 5.



*Fig. 1*



*Fig. 2*



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## EUROPEAN SEARCH REPORT

Application Number  
EP 02 08 0618

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CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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